Allen-Bradley

DriveGuard®

Safe-Off Option (Series B) for PowerFlex® 40P and PowerFlex® 70 AC Drives

User Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. "*Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls*" (Publication SGI-1.1 available from your local Rockwell Automation Sales Office or online at **http://www.rockwellautomation.com/literature**) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

Shock Hazard labels may be located on or inside the drive to alert people that dangerous voltage may be present.

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ControlNet is a trademark of ControlNet International, Ltd.
DeviceNet is a trademark of the Open DeviceNet Vendor Association.

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Summary of Changes

This is the initial release of the DriveGuard Safe-Off Option (Series B) *User Manual*.

General Description

The DriveGuard Safe-Off option, when used with other safety components, helps provide protection according to EN 954-1:1997; Category 3 for safe-off and protection against restart. The DriveGuard Safe-Off option is just one component in a safety control system. Components in the system must be chosen and applied appropriately to achieve the desired level of operator safeguarding.

What Is the DriveGuard Safe-Off Option?

The DriveGuard Safe-Off Option Board:

- Is designed to help safely remove power from the gate firing circuits of the drive's output power devices (IGBT's). This helps prevent the drive's output power devices from switching in the pattern necessary to generate AC power to the motor.
- Can be used in combination with other safety devices to satisfy the requirements of EN 954-1, Category 3 for safe-off and help protect against restart.

Important: The option is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety.

ATTENTION: Electric Shock Hazard. Verify that all sources of AC and DC power are deenergized and locked out or tagged out in accordance with the requirements of ANSI/NFPA 70E, Part II.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's *User Manual* for locations). The voltage must be zero.

ATTENTION: In safe-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

Safety of Machinery Standards

The DriveGuard Safe-Off option meets the following council directives:

- EN 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General Requirements
- EN 954-1:1997; Category 3 - Safety-related parts of control systems

EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Drives comply with the EN standards listed below when installed according to the User and Reference Manuals.

CE Declarations of Conformity are available online at: **http://www.ab.com/certification/ce/docs**.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

Approved/Certified Equipment

Drive	Rating	TUV Certified	DriveGuard Safe-Off Option
PowerFlex 40P	240V	✔	Series B or greater
	480V	✔	Series B or greater
PowerFlex 70 Enhanced Control	240V	✔	Series A or greater
	400V	✔	Series A or greater
	480V	✔	Series A or greater

ATTENTION: Hazard of injury exists due to electric shock. Only install a Series B or greater DriveGuard Safe-Off option in a PowerFlex 40P Drive.

Installation and Wiring

The DriveGuard Safe-Off option is intended to be part of the safety related control system of a machine. Before installation, a risk assessment should be performed that compares the DriveGuard Safe-Off option specifications and all foreseeable operational and environmental characteristics of the machine to which it is to be fitted.

A safety analysis of the machine section controlled by the drive is required to determine how often the safety function should be tested for proper operation during the life of the machine.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation, Inc. cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

DriveGuard Safe-Off Option Installation

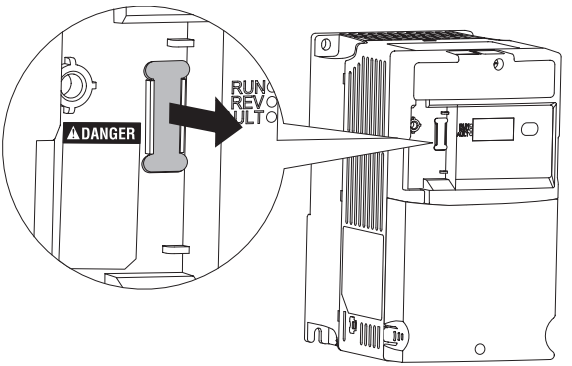
PowerFlex 40P Drives

1. Remove all power to the drive.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's *User Manual* for locations). The voltage must be zero.

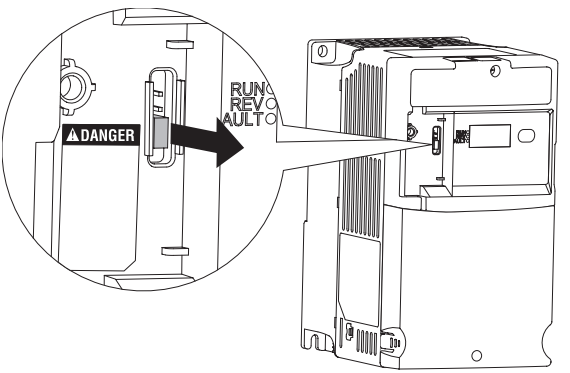
2. Remove the protective plug covering the PowerFlex 40P Safe-Off connector shown in Figure 1.

Figure 1 PowerFlex 40P Protective Plug



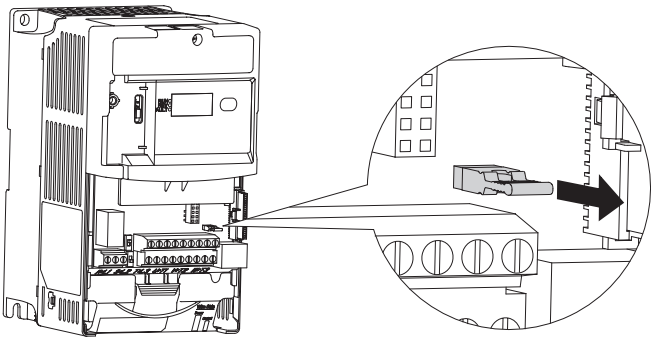
3. Remove the PowerFlex 40P Safe-Off connection jumper shown in Figure 2.

Figure 2 PowerFlex 40P Safe-Off Connection Jumper Location



4. Remove the PowerFlex 40P Hardware Enable jumper shown in Figure 3.

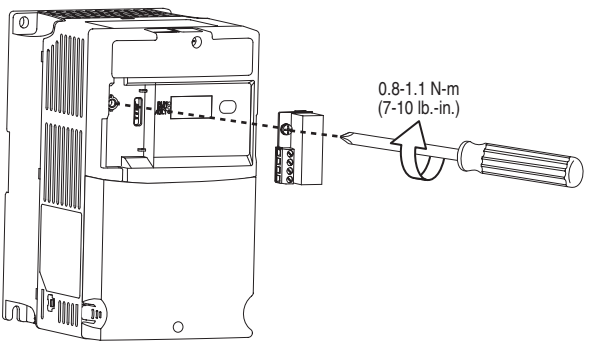
Figure 3 PowerFlex 40P Hardware Enable Jumper Location



Important: The PowerFlex 40P hardware enable jumper must be removed when using the DriveGuard Safe-Off option. Failure to remove the jumper may cause the drive to fault.

5. Plug the DriveGuard Safe-Off option (Series B or greater) into the PowerFlex 40P four pin safe-off connector as shown in Figure 4.

Figure 4 PowerFlex 40P Safe-Off Connector

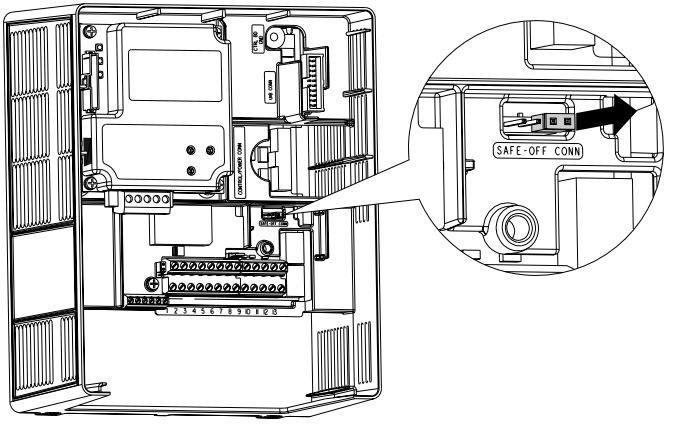


6. Tighten screw to 0.8-1.1 N-m (7-10 lb.-in.).

PowerFlex 70 Drives

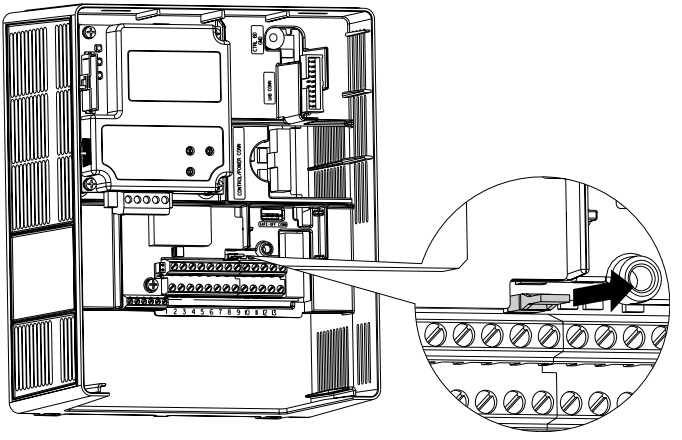
1. Remove the PowerFlex 70 Safe-Off Connection jumper as shown in Figure 5.

Figure 5 PowerFlex 70 Safe-Off Connection Jumper Location (Typical)



2. Remove the PowerFlex 70 Hardware Enable jumper as shown in Figure 6.

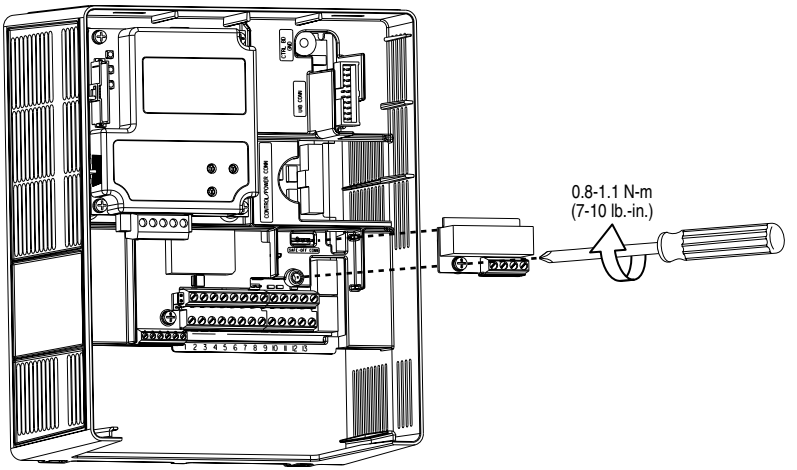
Figure 6 PowerFlex 70 Hardware Enable Jumper Location (Typical)



Important: The PowerFlex 70 hardware enable jumper must be removed when using the DriveGuard Safe-Off option. Failure to remove the jumper will cause the drive to fault when a start command is issued.

3. Plug the DriveGuard Safe-Off option (Series A or greater) into the PowerFlex 70 four pin connector as shown in Figure 7.

Figure 7 PowerFlex 70 Safe-Off Connector



4. Tighten screw to 0.8-1.1 N-m (7-10 lb.-in.).

Wiring

Important points to remember about wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control wires should be separated from power wires by at least 0.3 meters (1 foot).

Table 1 DriveGuard Safe-Off Option Terminal Block Specifications

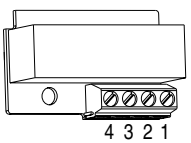
Wire Size Range(1)		Torque	
Maximum	Minimum	Maximum	Recommended
1.5 mm^2 (16 AWG)	0.14 mm^2 (26 AWG)	0.25 N-m (2.2 lb.-in.)	0.22 N-m (1.9 lb.-in.)

(1) Maximum / minimum that the terminal block will accept - these are not recommendations.

Table 2 Wire Types

	Wire Type(s)	Description	Minimum Insulation Rating
Unshielded	Per US NEC or applicable national or local code	—	300V, 60 degrees C (140 degrees F)
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equiv.)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	

Table 3 DriveGuard Safe-Off Option Terminal Description



No.	Signal	Description
1	Monitor - N.C.	Normally closed contacts for monitoring relay status. Maximum Resistive Load: 250V AC / 30V DC / 50 VA / 60 Watts Maximum Inductive Load: 250V AC / 30V DC / 25 VA / 30 Watts
2	Common - N.C.	
3	+24V DC	Connections for user supplied power to energize coil. 33.3 mA typical, 55 mA maximum.
4	24V Common	

Verify Operation

Test the safety function for proper operation after the initial installation of the DriveGuard Safe-Off option. Retest the safety function at the intervals determined by the safety analysis described on page 4.

Verify that both safety channels are functioning according to the drive-specific tables below.

Table 4 PowerFlex 40P Channel Operation and Verification

Safety Function Status	Drive In Safe State	Drive In Stopped State	Drive In Stopped State	Drive Able To Run
Safety Channel Operation				
Safe-Off Option Terminals 3 & 4	No Power Applied	Power Applied	No Power Applied	Power Applied
PowerFlex 40P Enable Input	No Power Applied	No Power Applied	Power Applied	Power Applied
Description For Verification				
Safe-Off Option Monitor Contact Terminals 1 & 2	Closed	Open	Closed	Open
PowerFlex 40P [Control In Status] Param. 13, Bit 2	Value = 0	Value = 0	Value = 1	Value = 1
PowerFlex 40P Comms Status Word 8448, Bit 0	Value = 0	Value = 0	Value = 0	Value = 1
Safe-Off Output(1) Relay N.O. Dig Output States	Closed	Open	Open	Open

(1) Must set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to option 25 “Safe-Off”.

Table 5 PowerFlex 70 Channel Operation and Verification

Safety Function Status	Drive In Safe State	Drive In Stopped State	Drive In(1) Stopped State	Drive Able To Run
Safety Channel Operation				
Safe-Off Option Terminals 3 & 4	No Power Applied	Power Applied	No Power Applied	Power Applied
PowerFlex 70 Enable Input	No Power Applied	No Power Applied	Power Applied	Power Applied
Description For Verification				
Safe-Off Option Monitor Contact Terminals 1 & 2	Closed	Open	Closed	Open
PowerFlex 70 Drive Inhibits Param. 214, Bit 2	Value = 1	Value = 1	Value = 0	Value = 0

(1) A Start/Run command will cause an F111 “Enable Hardware” fault.

Description of Operation

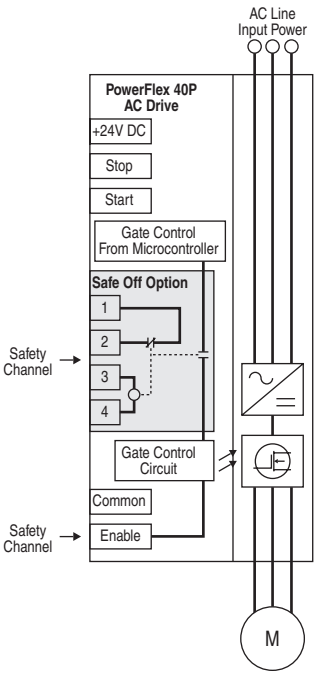
PowerFlex 40P Safe-Off Operation

The DriveGuard Safe-Off option for PowerFlex 40P (see Figure 8) disables the drive's output IGBT's by breaking the link with the drive microcontroller. When used in combination with a second safety channel (the Enable input), the system satisfies the requirements of EN 954-1, Category 3 for safe-off and helps protect against restart.

Under normal drive operation, the Safe-Off relay is energized, the enable input is energized, and the drive is able to run. If either input is de-energized, the gate control circuit becomes disabled. To meet EN 954-1, Category 3 operation, both safety channels must be de-energized. Refer to the following examples for details.

Important: By itself, the Safe-Off option initiates a coast-to-stop action. Additional protective measures will need to be applied when an application requires a change to the stop action.

Figure 8 PowerFlex 40P Drive Safe-Off Circuitry



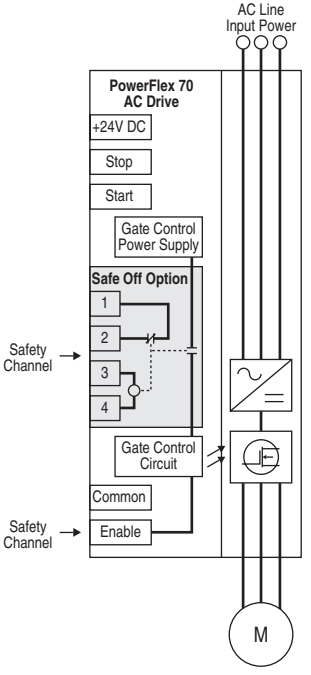
PowerFlex 70 Safe-Off Operation

The PowerFlex 70 Safe-Off option (see Figure 9) disables the drive's output IGBT's by disconnecting the gate control power supply. When used in combination with a second safety channel (the Enable input), the system satisfies the requirements of EN 954-1, Category 3 for safe-off and helps protect against restart.

Under normal drive operation, the Safe-Off relay is energized, the enable input is energized, and gate control power is available to the gate control circuit. If either of these inputs is de-energized, the gate control circuit is disabled. To meet EN 954-1, Category 3 operation, both safety channels must be de-energized. Refer to the following examples for details.

Important: By itself, the Safe-Off option initiates a coast-to-stop action. Additional protective measures will need to be applied when an application requires a change to the stop action.

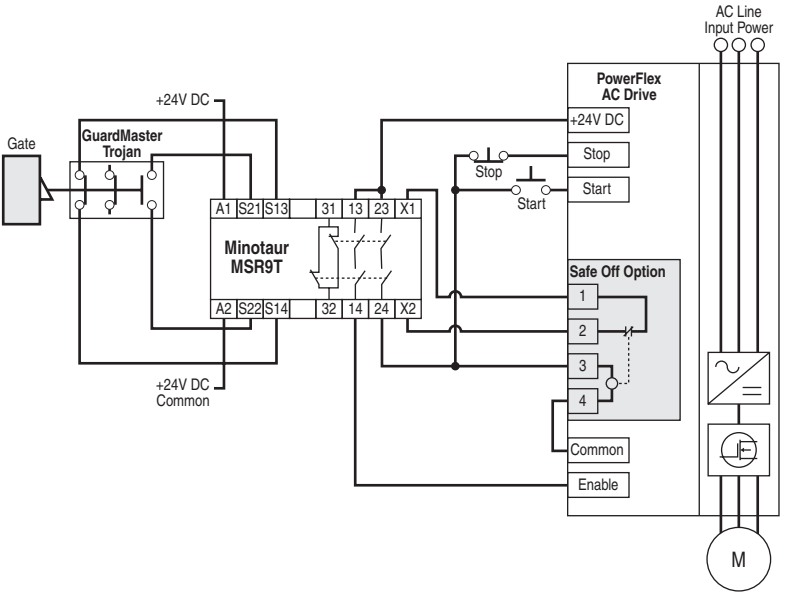
Figure 9 PowerFlex 70 Drive Safe-Off Circuitry



Connection Examples

Example 1
Safe-Off Connection with Coast-to-Stop Action, Dual Channel

Figure 10 Stop Category 0 – Coast



Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the safe-off circuit and drive. Opening the guard door will switch the input circuits (S13-S14 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14 & 23-24) will cause the Safe-Off option and drive Enable circuit to trip and the motor will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

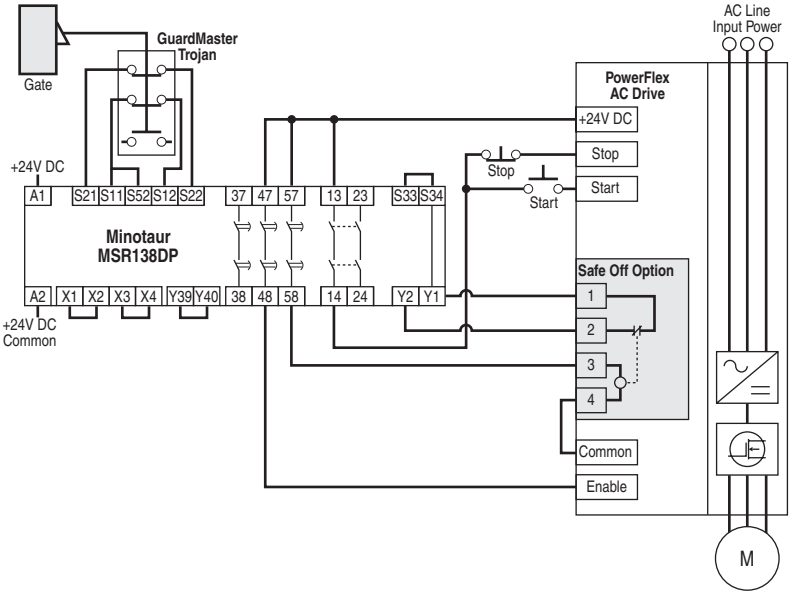
Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

If the Safe-Off option sticks ON, the motor will stop on command due to the enable input. The system cannot be reset when this fault condition exists.

Example 2
Safe-Off Connection with Controlled Stop Action, Dual Channel

Figure 11 Stop Category 1 – Controlled



Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the safe-off circuit and drive. Opening the guard door will switch the input circuits (S11-S12 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14) will issue a Stop command to the drive and cause a controlled deceleration. After the programmed delay, the timed output circuits (47-48 & 57-58) will cause the Safe-Off option and the drive Enable circuit to trip. If the motor is rotating when the trip occurs, it will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

If the Safe-Off option sticks ON, the motor will stop on command due to the enable input. The system cannot be reset when this fault condition exists.

Supplemental Information

PowerFlex 40P Certification

TÜV **TÜV Rheinland Group**

TÜV Rheinland Industrie Service GmbH
Automation, Software und Informationstechnologie

ZERTIFIKAT
CERTIFICATE

Nr./No. 968/EZ 226.00/06

Prüfgegenstand/ Product tested	Safety function "Safe standstill" within the Adjustable Frequency AC Drive	**Zertifikatsinhaber/ License holder**	Rockwell Automation 6400 West Enterprise Drive USA-Mequon, WI 53092 United States of America
Typbezeichnung/ Type designation	Allen-Bradley PowerFlex 40P AC Drive 200/240 VAC and 380/480 VAC	**Verwendungszweck/ Intended application**	Safety relevant applications with the Safety Function "Safe standstill" according to EN 954-1category 3
Prüfgrundlagen/ Codes and standards forming the basis of testing	EN 954-1:1996 EN ISO 13849-2:2003 EN 60204-1:1997 EN 50178:1997 EN 61800-3:2004		
Prüfungsergebnis/ Test results	The safety function "Safe standstill" fulfils the requirements for category 3 according EN 954-1.		
Besondere Bedingungen/ Specific requirements	The possibility of the small movement of the motor resulting from simultaneous IGBT failures must be taken into account during the hazard analysis of the system. The external wiring has to meet the requirements for fault exclusions according to Annex D.5.2 (Table D.4) of EN ISO 13849-2. The user manual "Safe-Off Option for PowerFlex 40P and PowerFlex 70 AC Drives" has to be considered.		

TÜV Functional Safety FS TÜV Rheinland Group Type Approved

Der Prüfbericht-Nr. 968/EZ 226.00/06 vom 2006-05-11 ist Bestandteil dieses Zertifikates.
Der Inhaber eines für den Prüfgegenstand gültigen Genehmigungs-Ausweises ist berechtigt, die mit dem Prüfgegenstand übereinstimmenden Erzeugnisse mit dem abgebildeten Prüfzeichen zu versehen.

The test report-no. 968/EZ 226.00/06 dated 2006-05-11 is an integral part of this certificate.
The holder of a valid licence certificate for the product tested is authorized to affix the test mark shown opposite to products, which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Geschäftsfeld ASI
Automation, Software und Informationstechnologie
Am Grauen Stein, 51105 Köln
Postfach 91 09 51, 51101 Köln

2006-05-11
Datum/Date

Firmenstempel/Company seal

Unterschrift/Signature

PowerFlex 70 Enhanced Control Certification

TÜV Rheinland Group

TÜV Anlagentechnik GmbH
Automation, Software und Informationstechnologie

ZERTIFIKAT
CERTIFICATE

Nr./No. 968/EZ 166.00/04

Prüfgegenstand/ Product tested	Adjustable Frequency AC Drive	**Zertifikatsinhaber/ Licenseholder**	Rockwell Automation 6400 West Enterprise Drive LSA-Mequon, WI 53092 United States of America
		Hersteller/ Manufacturer	Rockwell Automation, Inc. 1201 W. 1st Street, LSA-Sumner, Iowa 50674 United States of America
Typbezeichnung/ Type designation	Allen Bradley PowerFlex 70 AC Drive Frame Size 240V, 400V, 480V Frame A/B/C/D	**Verwendungszweck/ Intended application**	Safety relevant applications; Safety Function "Safe stand-still" according to EN 954-1 category 3
Prüfgrundlagen/ Codes and standards forming the basis of testing	EN 954-1:1996 DIN EN ISO 13849-2:2003 EN 60204-1:1997 DIN EN IEC 61508:1998 EN 61800-3:1996 & A11:2000		
Prüfungsergebnis/ Test results	The safety function "Safe standstill" fulfil the requirements for category 3 according EN 954-1.		
Besondere Bedingungen/ Specific requirements	The possibility of the small movement of the motor resulting from simultaneous IGBT failures must be taken into account during the hazard analysis of the system. Fault exclusion for the external wiring has to be made according to DIN EN ISO 13849-2. The user manual "Safe Off Option for PowerFlex 70 AC Drive" (Publication PFLEX-UM002A-EN-P-February 2004) and "PowerFlex 70 Adjustable AC Drive" (Publication 20A-UM002F-EN-P-July 2002) have to be considered.		

Der Prüfbericht-Nr. 968/EZ 166.00/04 vom 2004-02-25 ist Bestandteil dieses Zertifikates.
Der Inhaber eines für den Prüfgegenstand gültigen Genehmigungs-Ausweises ist berechtigt, die mit dem Prüfgegenstand übereinstimmenden Erzeugnisse mit dem abgebildeten Prüfzeichen zu versehen.
The test report-no. 968/EZ 166.00/04 dated 2004-02-25 is an integral part of this certificate.
The holder of a valid licence certificate for the product tested is authorized to affix the test mark shown opposite to products, which are identical with the product tested.

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2004-02-25

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